Space Weather Technical Forecast

Issued on Saturday 15 March 2025 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely. Chance G1/Minor Storms Days 2-3 (16-17 Mar). Active electron fluence expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a peak flare reaching M1.1 at 14/2221 UTC from a newly numbered region AR4030, lying immediately east of AR4028, and near the southeast limb. There are twelve regions on the disc. AR4019 has changed little although the delta spot is now apparent again. AR4022 has developed fairly rapidly in the last 24 hours, but so far has a straightforward magnetic structure. AR4028 and the two new regions near it are difficult to assess close to the limb, but so far appear to have straightforward magnetic structures. The proximity of these three regions suggests there could be some interaction between them. The remaining regions appear fairly small and simple at present, but looping in SDO imagery suggests there may be further regions to rotate onto the east limb in the near future.

No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: An ongoing High Speed Stream from CH22/- was observed. Solar winds, as measured by ACE at L1, were at elevated levels, mainly between 500-600 km/s. Density was below average. Interplanetary Magnetic Field, Bt, was weak below 8nT, with the north-south component, Bz, varying weakly between +6/-6nT. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was at unsettled to active levels (Kp 3-4) throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was mostly moderate to high, with a peak of 3980 pfu at 14/1650 UTC. The 24-hour fluence rose close to the Active threshold (1e8 integrated pfu), recording 9.95e7 integrated pfu at 15/0000 UTC, and then soon after rose through the threshold on a gently rising trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with isolated M-class flares likely.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed Coronal Mass Ejections (CMEs) although one was observed leaving the southwest limb around 15/0600UTC and this could result in a glancing blow during this guidance period.. Conditions are likely to very slowly ease during Days 1-2 (15-16 Mar), before the next solar wind enhancement probably occurs from

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CH23/-, with solar winds rising again to elevated levels. However it is possible that a more continuous spell of fast winds may occur throughout the period, which would reduce the potential for geomagnetic activity on Days 2-3 (16-17 Mar).

Due to this, confidence is lower than would typically be expected for this situation. Unsettled to Active geomagnetic activity is expected. Chance of G1/Minor Storms intervals for the next one to three Days should we see a more definite onset of CH23.

Energetic Particles / Solar Radiation: High energy proton flux is likely to be at background levels, but with a slight chance of an enhancement, should there be any larger flares mainly from the west of the disc. High energy electron flux is expected to reach High levels at the diurnal maxima, with Active (1e8 integrated pfu) fluence expected at first but confidence lowers through the guidance period.

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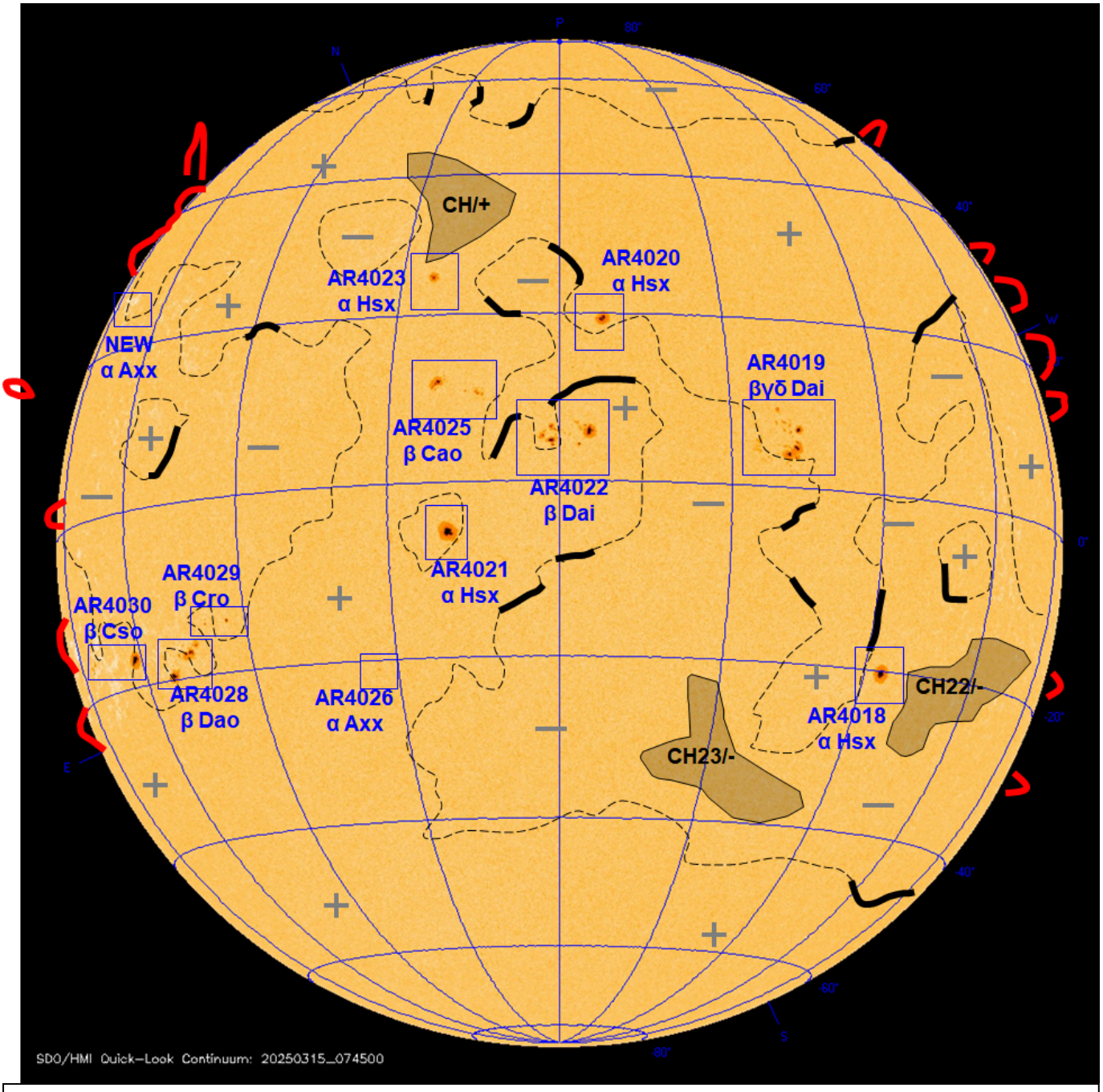
Figure 1: Solar synoptic map, valid 15/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs currently in the forecast.

Solar winds are elevated due to the fast wind of CH22/- and have been fairly steady through the last 24 hours. Conditions are likely to very slowly ease during Day 1 and perhaps Day 2 (15-16 Mar), before the next solar wind enhancement probably occurs from CH23/-, with solar winds rising again to elevated levels near or above 500 km/s. However it is worth nothing that CH23/- and CH22/- were a single feature until the development of AR4018 and its nearby flux emergence, which potentially obscures any connection that these features may still have. Due to this, it is possible that a more continuous spell of fast winds may occur throughout the period, which would reduce the potential for geomagnetic activity on Days 2-3 (16-17 Mar), due to the lack of any CIR region. This is supported by both MOSWOC Enlil and also 27-day persistence adding to the potential uncertainty.

Due to this, confidence is lower than would typically be expected for the onset of geomagnetic activity from a negative coronal hole at this time of year. Geomagnetic actvity expected to be at Unsettled to Active levels. However given the current and expected solar wind levels, there is a chance of G1/Minor Storms over the coming three days, especially if we see a CIR at the onset of CH23.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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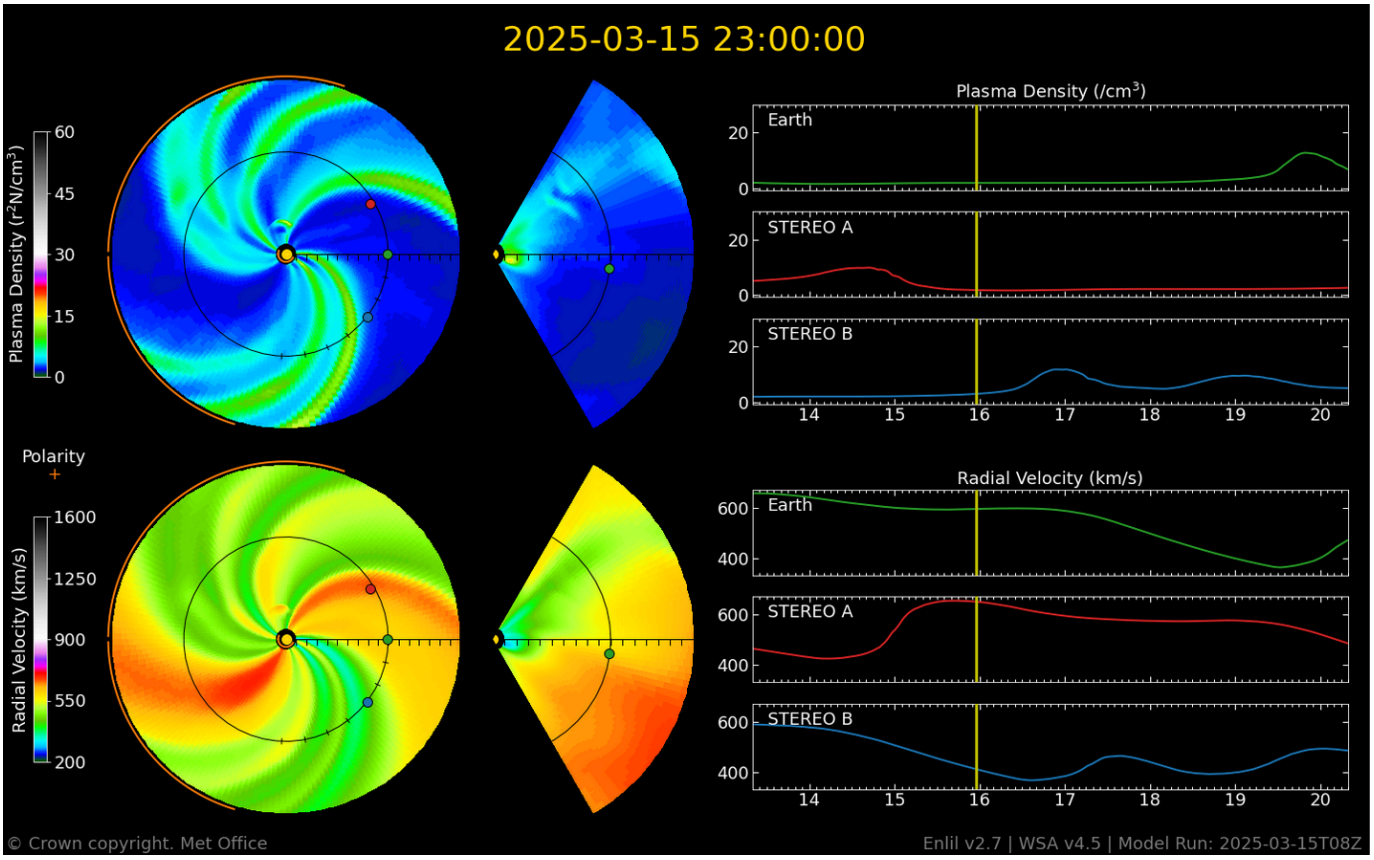
Figure 2: MOSWOC Enlil, suggesting elevated wind speeds gradually easing later in the guidance period.



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Radio Blackouts - X-Ray Flares

Solar activity has been Moderate with the peak flare M1.1 at 14/2221 UTC from the new region east of AR4028, near the southeast limb.

Twelve regions cover the visible disc. AR4019, in the northwest, has shown some redistribution of the leading and intermediate spots in recent hours with a small delta spot becoming apparent once more. AR4022, near centre-disc, has grown steadily in the past 24 hours, and retains a straightforward magnetic structure. AR4028 in the far southeast and the two new regions near it have just been numbered. The proximity of these three regions suggests there could be some magnetic interaction between them. The remaining regions appear fairly small and simple at present.

Solar activity has been Moderate with the peak flare M1.1 at 14/2221 UTC from the new region AR4030, immediately east of AR4028, near the southeast limb. Low to Moderate activity is expected, with an ongoing likelihood of isolated M-class flares. Both persistence and far side seismographs, alongside the looping in SDO imagery, suggest that there may be more regions to arrive on the disc in the coming days. It is difficult to assess the likely activity of these regions until they become visible, however, so the flare probability has been kept flat for the time being.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	5	5	5	5

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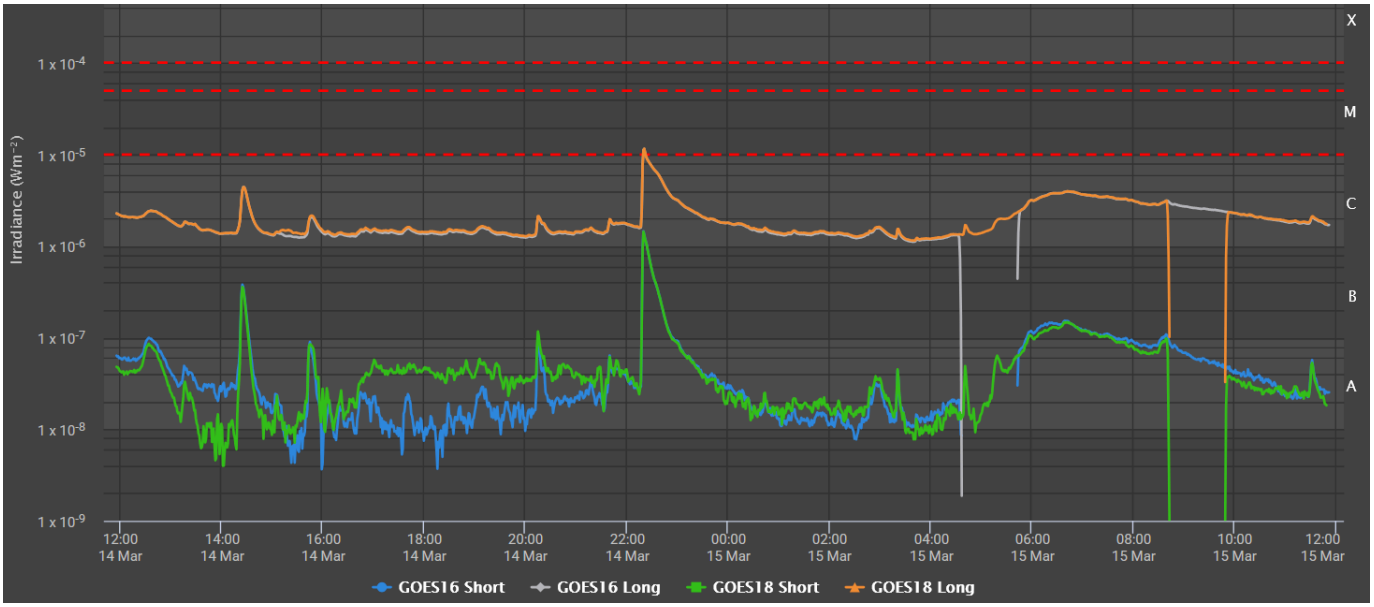
Figure 3: X-ray flux at GOES16 and 18, showing one M-class flare in the last 24 hours.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is likely to remain at background levels as none of the regions on the disc are significantly complex and therefore unlikely to produce enhancements above the S1 level. However, there remains a slight risk should any of these regions produce a larger flare, and the risk increases a little by Day 4 (18 Mar) as these regions rotate westwards into the area which is more likely to connect any proton enhancements with Earth.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

Despite the ongoing fast wind from CH22/-, some outward expansion of the Van Allen belts has been occurring with periods of high flux observed by GOES-16. This has been significantly higher and longer lasting during 14 March, allowing the 24 hour fluence to rise close to the Active (1e8 integrated pfu) threshold. Overall, electron flux is most likely to continue peaking at high levels during the diurnal maxima in the coming days. However, there is some potential for periods of dropout associated with any geomagnetic activity that occurs. This is most likely if we see a CIR at the onset of CH23/- on Days 2-3 (16-17 Mar), although this is low confidence and the current fast wind from CH22 could merge into CH23 without any significant geomagnetic effects.

Overall the fluence is currently rising, and is now just above the Active threshold. Confidence decreases through the guidance period due to the uncertainty regarding the next HSS arrival. MOSWOC REFM is suggesting that fluence will remain mostly above Active during the next 4 days, which seems like reasonable guidance at the present time, although perhaps with overall values slightly too high.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	Yes	100	90	70	50
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	5

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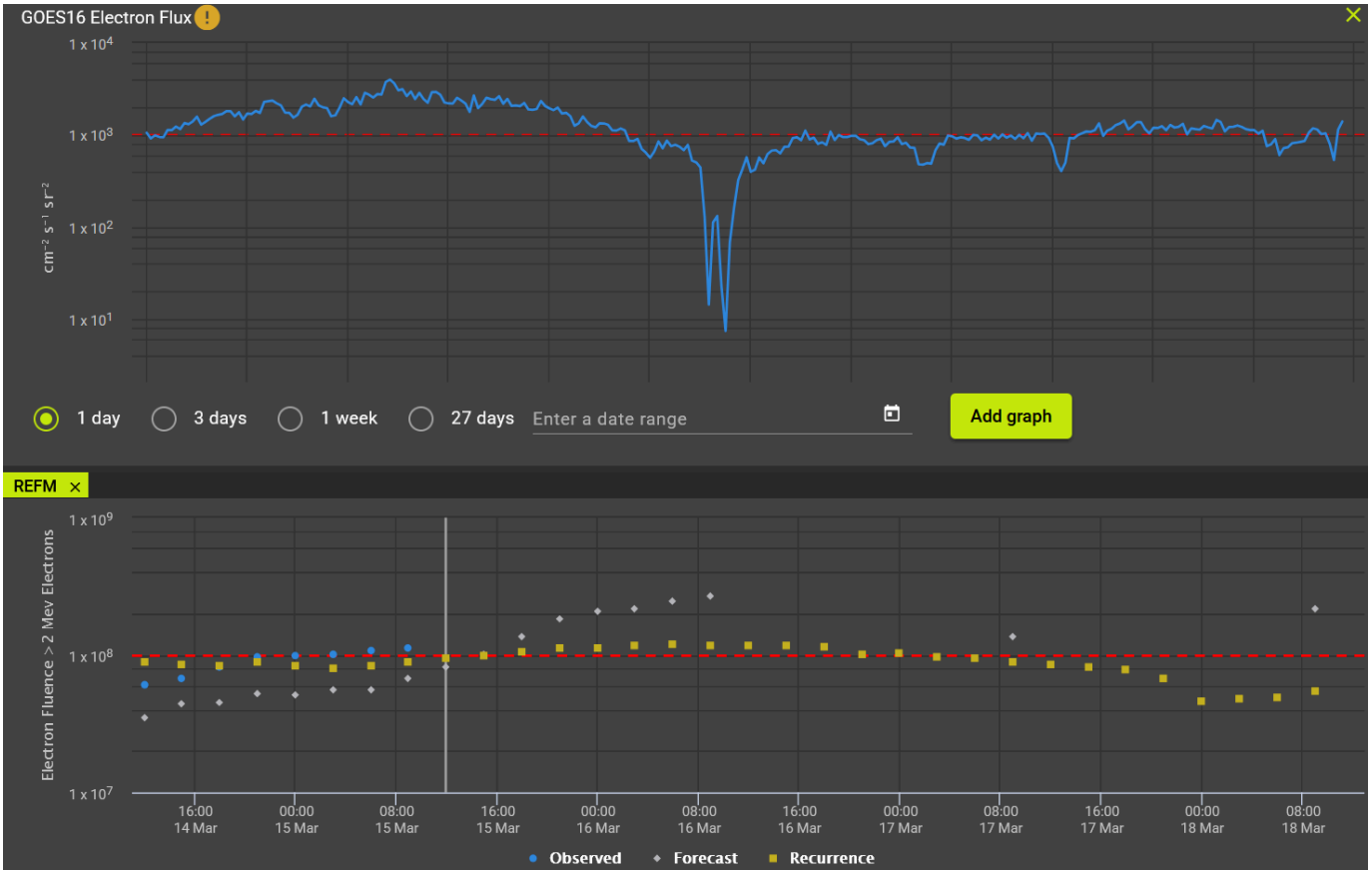
Figure 4: MOSWOC REFM showing fluence just above Active threshold and forecasting a further rise over the next 18 to 24 hours.



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